

What is claimed is:

1. A reverse spreading device for reversely spreading complex base band signal, one being composed of an I (In-phase signal) component and another being composed of a Q (Quadrature phase signal) component and each being spread using spread codes of n-pieces of chips for one symbol signal comprising:
- a first correlator having first delay devices whose number is an integral multiple of n-1 and which sequentially shift said base band signal composed of said I component by delaying it at a predetermined time interval, having n-pieces of first multipliers each performing a multiplication between said base band signal composed of said I component shifted by said first delay devices and a spread code and having m-pieces of first adders each performing integration of an output from k-pieces of said first multipliers out of n-pieces of said first multipliers and outputting the result of said integration as an intermediate signal composed of said I component ($m=n/k$);
- a second correlator having second delay devices whose number is the same as that of chips for one symbol signal sequentially shifted by delaying said base band signal composed of said Q component at a predetermined time interval, having n-pieces of second multipliers each performing a multiplication between said base band signal composed of said I component sequentially shifted by said second delay devices and said spread code and having m-pieces of second adders each performing integration of an output from k-pieces of said first multipliers out of n-pieces of said first multipliers and outputting the result of said integration as an intermediate signal composed of said Q component;

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28 m-pieces of phase rotators each performing a rotation
29 correction by phase-rotating m-pieces of said intermediate signals
30 each being composed of said I component produced by each of said
31 first correlators and m-pairs of complex intermediate signals
32 containing m-pieces of intermediate signals composed of said Q
33 component produced by said each of said second correlators, on
34 a complex plane at a phase rotation angle at m-stages each being
35 slid by a reference rotation angle for every pair of said complex
36 intermediate signals;

37 a first adder to perform calculation of a correlation value
38 composed of said I component by doing integration of said I component
39 of said m-pieces of said complex intermediate signals obtained
40 after said rotation correction is made by each of said phase
41 rotators; and

42 a second adder to perform calculation of a correlation value
43 composed of said Q component by doing integration of said Q component
44 of said m-pieces of said complex intermediate signals obtained
45 after said rotation correction of each of said phase rotators is
46 made.

2. A reverse spreading device for reversely spreading complex base band signals, one being composed of an I (In-phase signal) component and another being composed of a Q (Quadrature phase signal) component and each being spread using spread codes of n-pieces of chips for one symbol signal comprising:

6 a first multiplier to sequentially perform a multiplication
7 between base band signals composed of said I component and said
8 spread codes of n-pieces of chips;

9 a first correlator to produce m-pieces of intermediate

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10 signals composed of said I component by sequentially integrating
11 said multiplied value obtained by said first multiplier for every
12 k-pieces and by using said multiplied value as said intermediate
13 signal and to output them as $(m=n/k)$;

14 a second multiplier to sequentially perform a multiplication
15 between said base band signals composed of said Q component and
16 said spread codes of n-pieces of chips;

17 a second correlator to produce m-pieces of intermediate
18 signals composed of said Q component by sequentially integrating
19 said multiplied value obtained by said first multiplier for every
20 k-pieces multiplied values and by using said multiplied value as
21 said intermediate signals and to output them;

22 a phase rotator to perform a rotation correction by
23 phase-rotating m-pieces of complex intermediate signals
24 containing said intermediate signal composed of said I component
25 and said intermediate signal each composed of said Q component
26 on a complex plane at a phase rotation angle at m-stages each being
27 slid by a reference rotation angle for every pair of said complex
28 intermediate signals;

29 a first adder to perform calculation of a correlation value
30 composed of said I component by doing integration of said I component
31 of said m-pieces of said complex intermediate signal obtained after
32 said rotation correction by each of said phase rotators is made;
33 and

34 a second adder to perform calculation of a correlation value
35 composed of said Q component by doing integration of said Q component
36 of said m-pieces of said complex intermediate signals obtained
37 after said rotation correction by each of said phase rotators is
38 made.

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1 3. A reverse spreading device for reversely spreading
2 complex base band signals, one being composed of an I (In-phase
3 signal) component and another being composed of a Q (Quadrature
4 phase signal) component and each being spread using spread codes
5 of n-pieces of chips for one symbol signal comprising:
6 a frequency error correcting device to count how many chips
7 of said complex base band signals to be inputted and to perform
8 a rotation correction in a step-by-step manner by rotating a phase
9 of said complex band signals on a complex plane at a phase rotation
10 angle at m-stages each being slid by a reference rotation angle
11 being an angle obtained by dividing a rotation angle (2π) of a
12 revolution to M portions every time a count of the chips increases
13 by K-chip;
14 a spread code multiplier to multiply each of complex base
15 band signals obtained after the rotation correction by said
16 frequency error correcting device is made, by said spread codes;
17 and
18 two accumulative adders to produce a correlation value
19 composed of said I component and a correlation value composed of
20 said Q component by performing accumulative addition of multiplied
21 value from said spread code multiplier for one symbol period for
22 each of said I component or Q component.

1 4. The reverse spreading device according to Claim 3,
2 wherein said frequency error correcting device is composed of a
3 chip number counter to sequentially count how many chips of said
4 complex base band signal to be inputted and to provide an instruction
5 for incrementing every time when count of chips increases by K-chips,
6 of a step number counter to increase said step number by one if

7 the outputted step number is a number other than M-1 and to return
8 said step number to 0 if said step number is M-1 in accordance
9 with said instruction for incrementing fed from said chip number
10 counter and of a phase rotator to perform a rotation correction
11 by rotating a phase of said complex base band signals at a phase
12 rotation angle corresponding to a step number fed from said step
13 number counter, out of phase rotation angles at M stages slid by
14 said reference rotation angle.

1 5. The timing detecting device comprising said reverse
2 spreading device claimed in Claim 1 and a peak detecting circuit
3 to detect spreading timing based on sizes of correlation values
4 of said I component and said Q component obtained by said reverse
5 spreading in said reverse spreading device.

1 6. The channel estimating device comprising said reverse
2 spreading device claimed in Claim 1 and a rotation correcting
3 circuit to detect a phase error contained in a complex symbol
4 obtained by said reverse spreading device and to perform correction
5 of said phase error.

1 7. The timing detecting device comprising said reverse
2 spreading device claimed in Claim 2 and a peak detecting circuit
3 to detect spreading timing based on sizes of correlation values
4 of said I component and said Q component obtained by said reverse
5 spreading in said reverse spreading device.

1 8. The channel estimating device comprising said reverse
2 spreading device claimed in Claim 2 and a rotation correcting

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3 circuit to detect a phase error contained in a complex symbol
4 obtained by said reverse spreading device and to perform correction
5 of said phase error.

1 9. The timing detecting device comprising said reverse
2 spreading device claimed in Claim 3 and a peak detecting circuit
3 to detect spreading timing based on sizes of correlation values
4 of said I component and said Q component obtained by said reverse
5 spreading in said reverse spreading device.

1 10. The channel estimating device comprising said reverse
2 spreading device claimed in Claim 3 and a rotation correcting
3 circuit to detect a phase error contained in a complex symbol
4 obtained by said reverse spreading device and to perform correction
5 of said phase error.

1 11. A method for measuring a frequency error being a
2 difference between a reference frequency of a receiver and a
3 reference frequency of a sender comprising steps of:

4 shifting sequentially a base band signal composed of an I
5 (In-phase signal) component and a base band signal composed of
6 a Q (Quadrature phase signal) component and performing a
7 multiplication between said shifted said base band signals each
8 being composed of said I component or said Q component;

9 performing integration of k-pieces of multiplied values out
10 of n-pieces of multiplied values obtained and producing m-pieces
11 of intermediate signals composed of an I component ($m=n/k$);

12 performing a rotation correction by rotating phases of
13 m-pairs of complex intermediate signals including m-pieces of

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14 intermediate signals composed of said I component and m-pieces
15 of intermediate signals composed of said Q component at a phase
16 rotation angle at m-stages each being slid by a reference rotation
17 angle for every one pair of complex intermediate signals;

18 calculating a correlation value of said I component and a
19 correlation value of said Q component by integrating said I
20 component and said Q component of said m-pieces of said complex
21 intermediate signals obtained after said rotation correction is
22 made; and

23 calculating a power value of a complex symbol based on said
24 correlation values of said I component and said Q component and
25 selecting said reference rotation angle so that said power value
26 becomes maximum and then detecting said frequency error based on
27 said reference rotation angle selected.

1 12. A method for measuring a frequency error being a
2 difference between a reference frequency of a receiver and a
3 reference frequency of a sender comprising steps of:

4 performing a multiplication between base band signals, one
5 being composed of an I component of n-pieces of chips and another
6 being composed of a Q component of n-pieces of chips and spread
7 code of n-pieces of chips and producing m-pieces of intermediate
8 signals, one being composed of said I component and said Q component
9 by integrating a multiplied value for every k-pieces of said
10 multiplied value and to use an integrated value as an intermediate
11 signal ($m=n/k$);

12 performing a rotation correction by rotating phases of
13 m-pairs of complex intermediate signals including m-pieces of
14 intermediate signals composed of said I component and m-pieces

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15 of intermediate signals composed of said Q component at a phase
16 rotation angle at m-stages each being slid by a reference rotation
17 angle for every one pair of complex intermediate signals;

18 calculating a correlation value of said I component and a
19 correlation value of said Q component by integrating said I
20 component and said Q component of said m-pieces of said complex
21 intermediate signals obtained after said rotation correction is
22 made; and

23 calculating a power value of a complex symbol based on said
24 correlation values of said I component and said Q component and
25 selecting said reference rotation angle so that said power value
26 becomes maximum and then detecting said frequency error based on
27 said reference rotation angle selected.

1 13. A method for measuring a frequency error being a
2 difference between a reference frequency of a receiver and a
3 reference frequency of a sender comprising steps of:

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4      counting how many chips of complex base band signals are
5  to be inputted;
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6 performing a rotation correction in a step-by-step manner
7 by rotating a phase of said complex band signal on a complex plane
8 at a phase rotation angle at m-stages each being slid by a reference
9 rotation angle being an angle obtained by dividing a rotation angle
10 (2π) of a revolution to M portions every time said counted number
11 of the chips increases by K- chip

12 multiplying complex base band signals by spread signals
13 obtained after the rotation correction is made by said frequency
14 error correcting device;

15 producing a correlation value of the I component and a

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16 correlation value of the Q component by adding the multiplied value
17 fed from said spread code multiplier in an accumulative manner
18 for every I component and every Q component during one symbol period;
19 calculating a power value of the complex symbol based on
20 the correlation values of said I component and said Q component
21 and selecting said reference rotation angle so that the power value
22 becomes maximum and then detecting said frequency error based on
23 said reference rotation angle selected.

1 14. An AFC (Automatic Frequency Control) method to control
2 a frequency of a reference frequency signal of a mobile station
3 so that a frequency error measured by said frequency error measuring
4 method claimed in claim 11.

1 15. An AFC (Automatic Frequency Control) method to control
2 a frequency of a reference frequency signal of a mobile station
3 so that a frequency error measured by said frequency error measuring
4 method claimed in claim 12.

1 16. An AFC (Automatic Frequency Control) method to control
2 a frequency of a reference frequency signal of a mobile station
3 so that a frequency error measured by said frequency error measuring
4 method claimed in claim 13.

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